Radiation Physics

Prof. Dr. Eman Abd Elaziz Ahmed
Oral & Maxillofacial Radiology

Intended Learning Outcomes ILO'S

- Define radiation.
- Identify types and properties of radiation.
- Define roentgen rays.
- Discuss properties of roentgen rays
- Discuss production of x-rays
- Identify different components of x-ray machine and their functions.

Discovery Of Roentgen Rays

Discovery Of Roentgen Rays

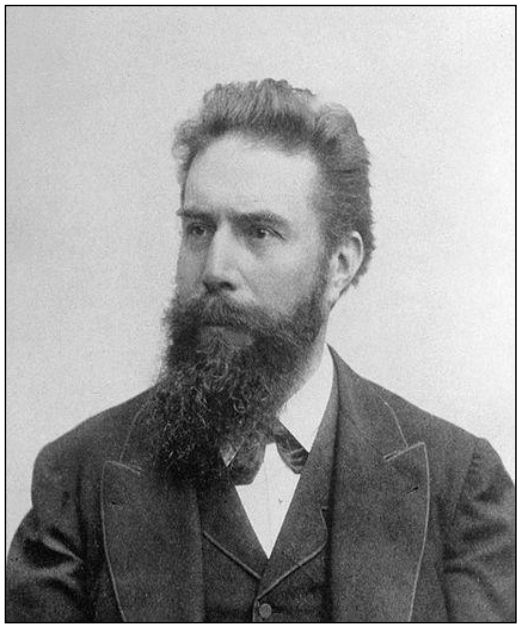
The father of diagnostic radiology

Wilhelm Conrad Röentgen

German physicist

1895

The first nobel prize in physics in 1901.



27 March 1845 - 10 February 1923

Discovery Of Roentgen Rays

Wilhelm Röntgen's first "medical" x-ray, of his wife's hand "Anna Bertha" , taken on 22 December 1895

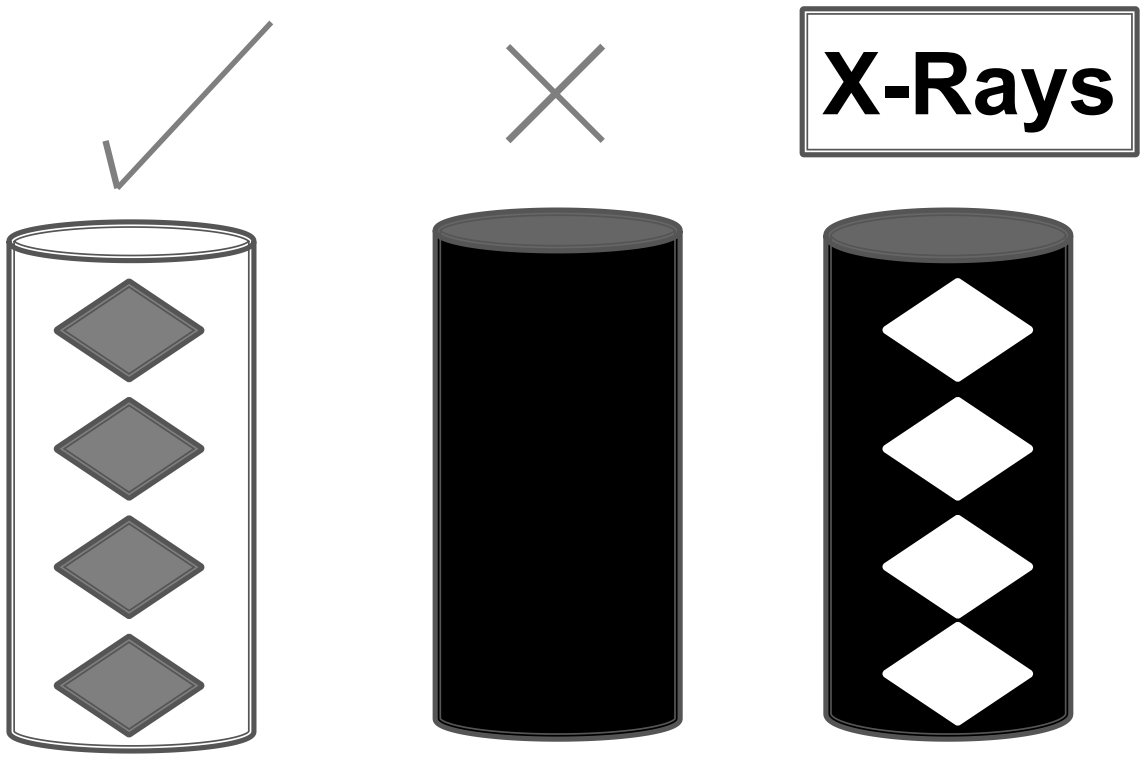
Clinical Exam + Radiographs

↓

Diagnosis

↓

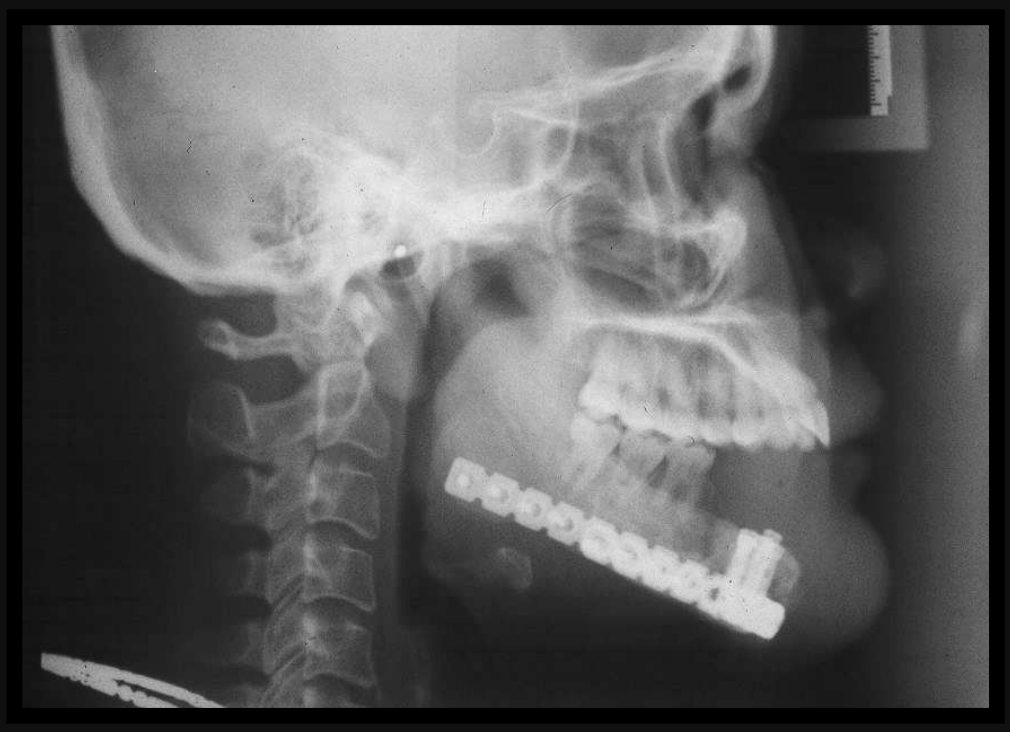
Treatment



Bitewing Radiograph

Periapical Radiograph

Panoramic Radiograph



Cephalometric Radiograph

Object

X-rays

Film

Processing

Radiograph

What is the Matter?

Matter

What is the matter?

Any thing that:

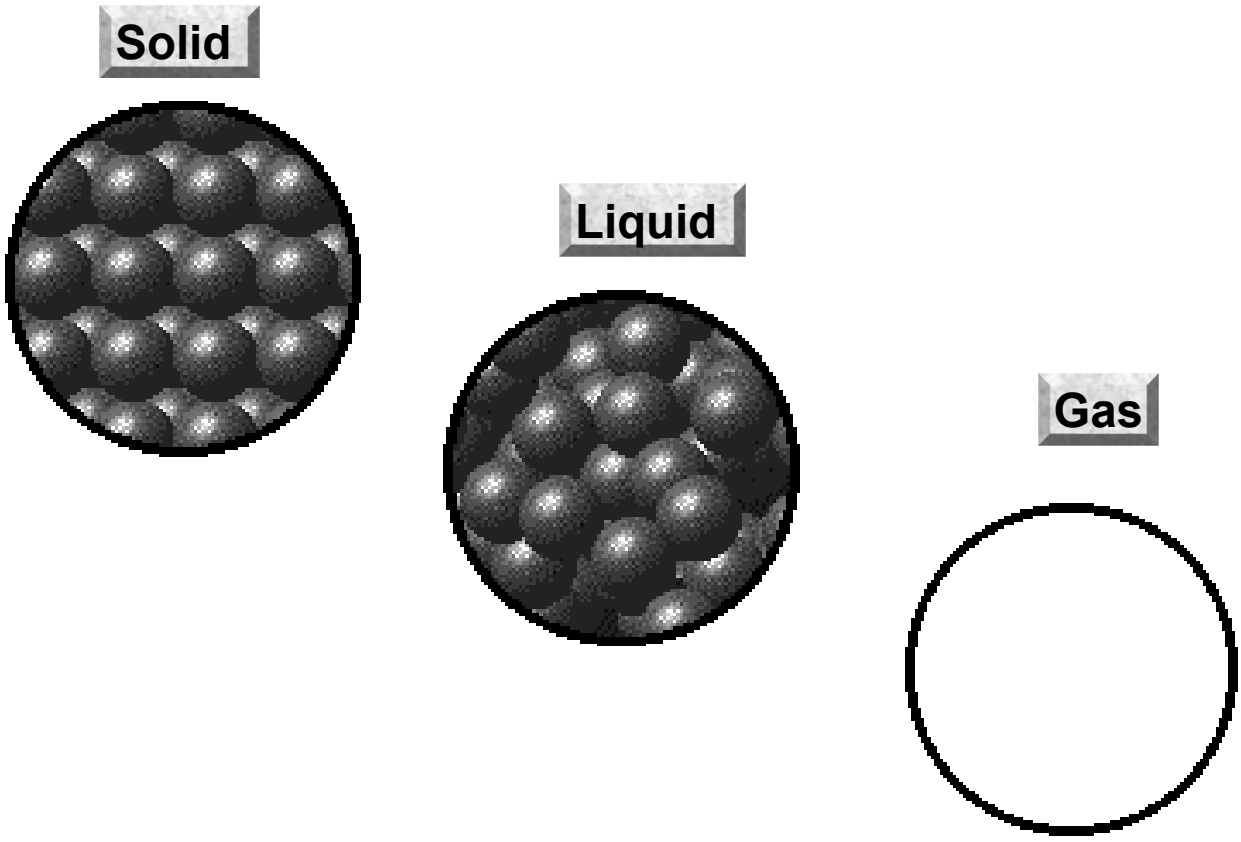
1. Occupies space.
2. Has a mass.
3. Can exert force.
4. Or be acted on by force.

Matter

According to the degree of attraction between the atoms forming the matter, the matter exists in three states:

Matter	Attraction Force
Solid	Highest
Liquid	Medium
Gas	Lowest

States of Matter



Atom

What is the atom?

- It’s the smallest division of an element that can enter in the chemical reaction.
- It’s the fundamental unit of any particular element.

Atom

Can you divide the atom by ordinary means?

Is it like hazelnut?

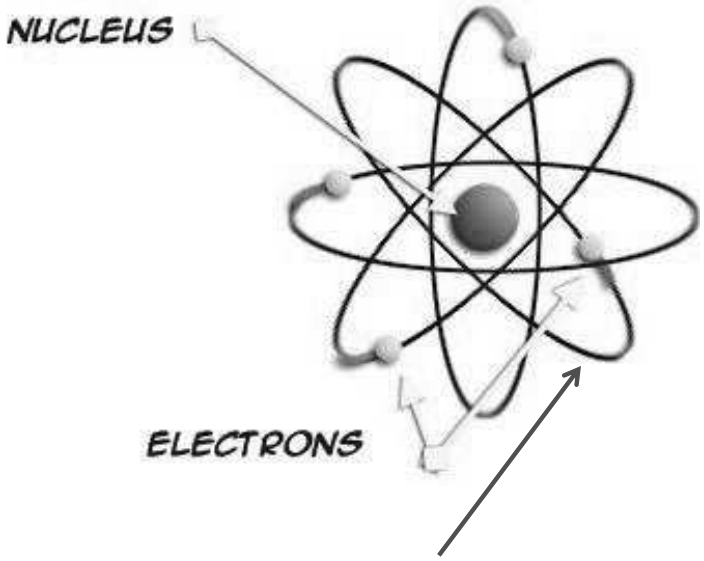
Atomic structure

- **Nucleus**

- Protons (+ve).
- Neutrons (neutral).

So The charge of nucleus depend on protons.

- **Orbiting electrons (-ve)**



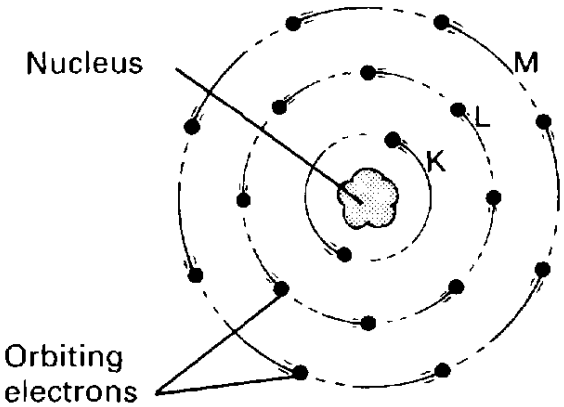
Orbits or shells

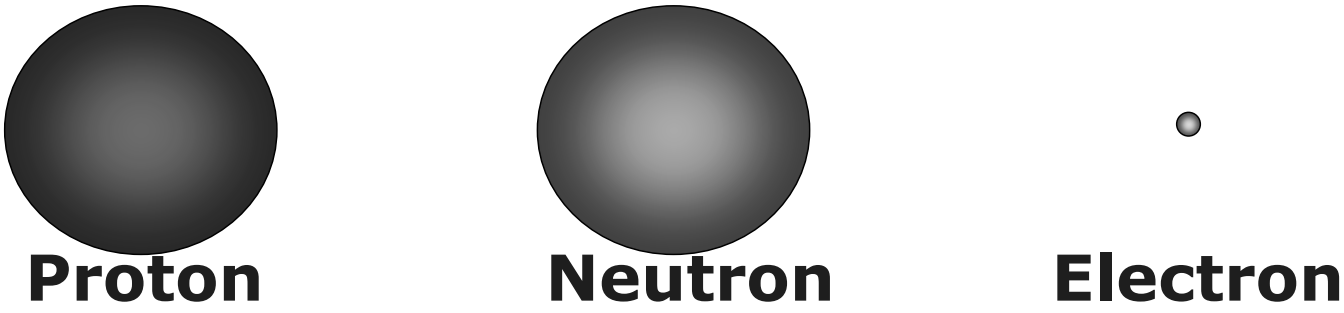
Atomic structure

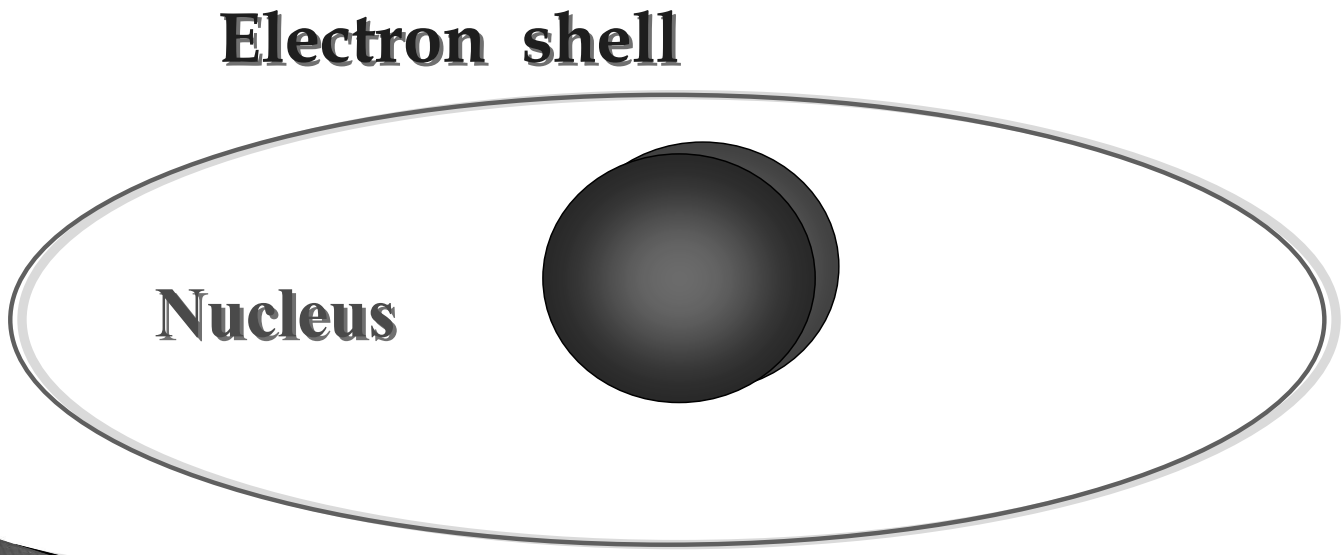
- **Nucleus**

- Protons (+ve)
- Neutrons (neutral)

- **Orbiting electrons (-ve)**







The Atom

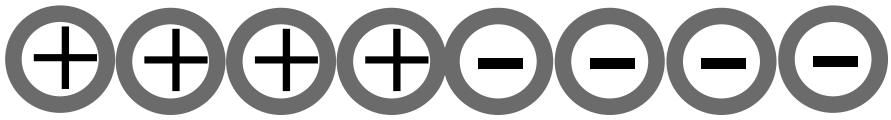
Forces inside the atom

- **The atom present in balanced state due to equalization between two forces:**

1. The electrostatic force of attraction.
2. The centrifugal force.

Electrostatic Force

Attraction between protons and electrons



Centrifugal Force

Due to the revolution of electrons in curved path rapidly around the nucleus.

Atomic Number

It’s the number of protons in the nucleus, which is equal to the number of electrons in the orbits.

Protons = electrons
+ -

Atomic Mass Number

Total number of protons and neutrons in the nucleus.

Protons + neutrons

States of atom

- Ground (normal, stable) state
- Excitation state
- Ionization state

States of atom

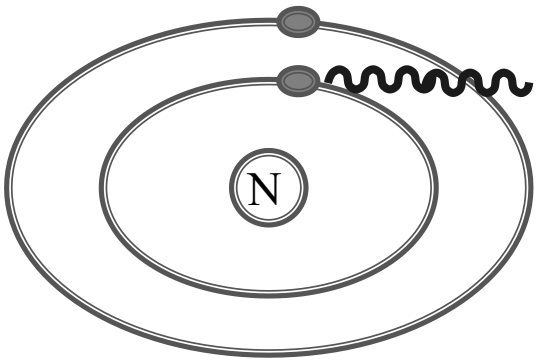
Ground (normal, stable) state:

1. Electrically neutral.
2. Number of protons = Number of orbital electrons.
   +ve charge -ve charge

States of atom

Excitation state:

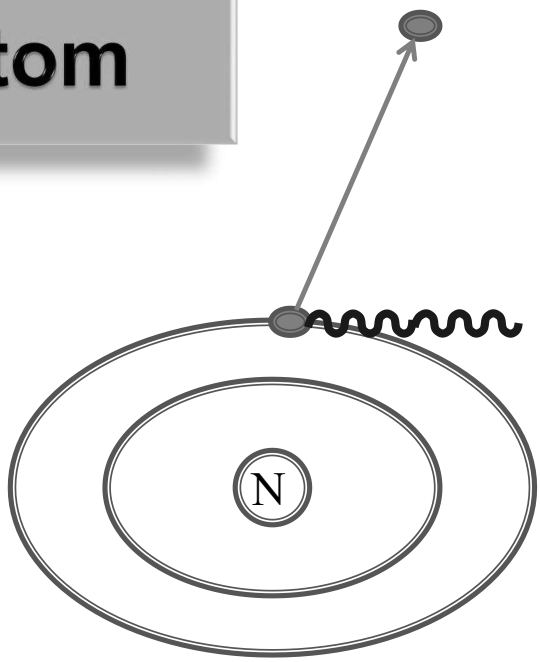
It's the process by which sufficient energy ejects an electron from its normal level to a higher energy level.



States of atom

Ionization state:

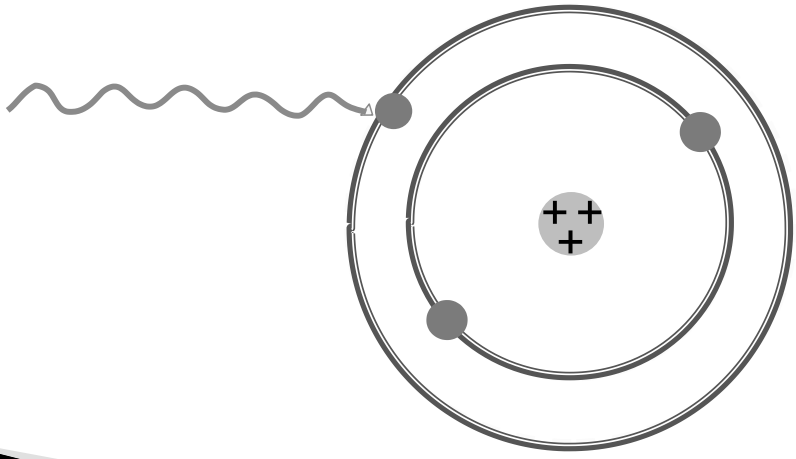
It's the process by which an atom loses its electrical neutrality and becomes an ion by removal or adding of an electron.



Ion Pair Formation

X-rays are capable of causing this Ionization

negative ion



positive ion

Ion Pair Formation

If an electron is removed from or added to an atom, the atom is unstable and termed ------ an ion.

If an electron is removed from the atom , the atom becomes ---------- a +ve ion.

The removed electron is gained by another atom changes to ---------- a – ve ion.

Terminology

- **Radiology**
- **Roentgenology**
- **Dental roentgenology**
- **Radiography**
- **Radiograph**

Radiology

Science dealing with radiation applied on any field whether diagnostic, therapeutic or research application.

Roentgenology

Science dealing with Roentgen rays applied on any field whether diagnostic, therapeutic or research application.

Dental Roentgenology

It's the branch of science that is dealing with the use of Roentgen rays in diagnosis of dental diseases.

Radiography

It's the art of producing a shadow picture or image for specific object by passing x-rays through the structure to the sensitized plate.

Dental Radiography

It's the art of producing a shadow picture or image for intra or extra oral structures by generating and directing x-rays on a sensitized dental film.

Radiograph

It's a shadow picture or image of an object produced on a sensitized film by the use of x-rays.

Radiation Physics

Radiation

- **Radiation :**

  It is the emission, transmission and propagation of energy in space or in matter in the form of waves or particles.

- **Types of radiation:**

- Corpuscular (particulate)
- Electromagnetic

Corpuscular Radiation

Corpuscular Radiation

Definition:

It is that type of radiation given off from radioisotopes (natural or artificial) and during splitting of the atom.

Corpuscular Radiation

Characteristics:

- Minute particles
- Have a mass
- Have very high velocity
- Travel in straight lines
- Have a charge (except neutrons)
- Used in therapeutic purposes.

Corpuscular Radiation

Examples:

- Alpha (α) rays

- Beta (β) rays

- Subatomic particles

- Cathode rays

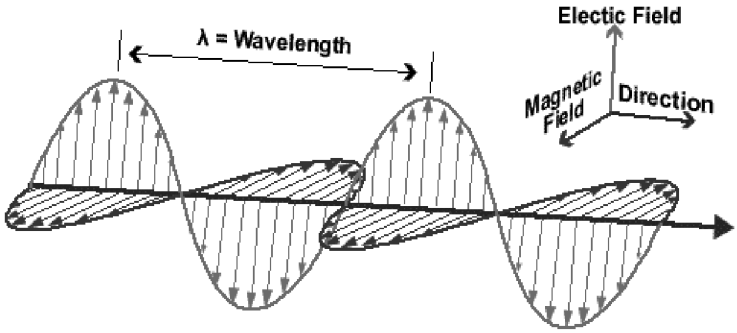
In Dentistry, Radiation Is Used Not Radioactivity

Electromagnetic Radiation

Electromagnetic Radiation

Definition :

It is that type of radiation formed of units of pure energy which are propagated in the form of waves as a combination of electric and magnetic field.



Electromagnetic Spectrum

- Arranged in an ascending order according to their wavelength(λ):

1. Cosmic rays
2. Gamma rays
3. X- rays(wavelength = 0.1-1 A˚)
4. Ultra-vilot rays
5. Visible light
6. Infrared rays (heat)
7. Microwaves
8. Radio ,radar and T.V. waves

Electromagnetic Radiation

Ionizing radiation	Non ionizing radiation
Radiation associated with sufficient energy to remove orbital electrons from an atom ---------- ion pair .	Radiation associated with insufficient energy to remove orbital electrons from an atom ---------- no ion pair.

Electromagnetic Radiation

Ionizing radiation	Non ionizing radiation
1. Cosmic rays 2. Gamma rays 3. X- rays	1. Ultra-vilot rays 2. Visible light 3. Infrared rays (heat) 4. Microwaves 5. Radio ,radar and T.V. waves

Electromagnetic Radiation

Properties:

- Pure energy units (photons or quanta).
- Have no mass or weight.
- Have no charge.
- Propagate in the form of wave
- Travel at the same speed of light
  (186000 miles/second)
  (3×10^8 m/second)

What is the difference between cathode rays and x-rays

?

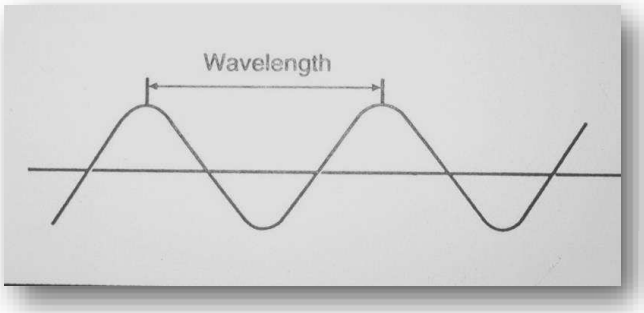
Electromagnetic Radiation

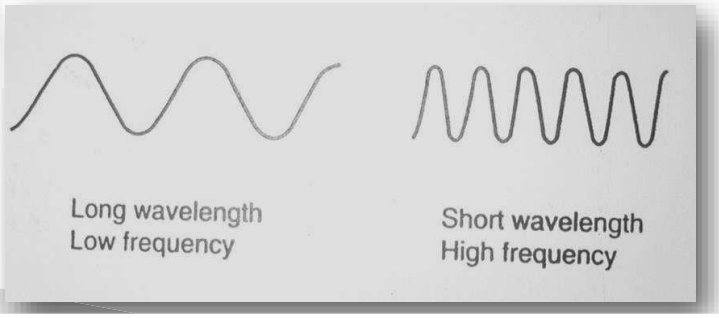
Properties:

They have velocity (C), wavelength (λ), frequency (ν)

$$C = \lambda \times \nu$$

3 x 10 ˚ meter/second **meters** **hertz (cycle/sec)**

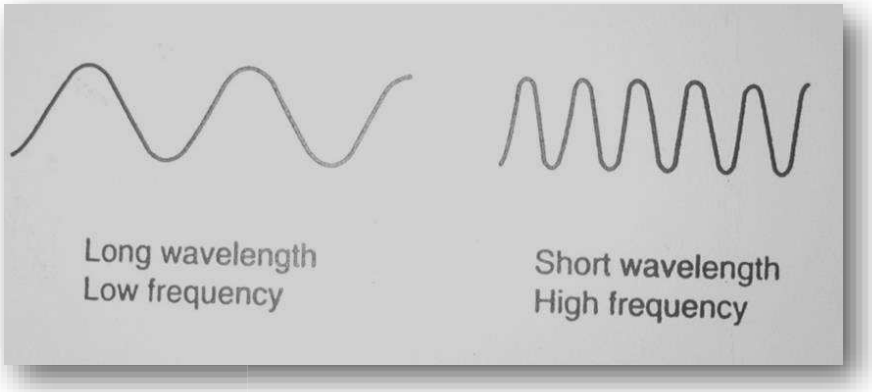




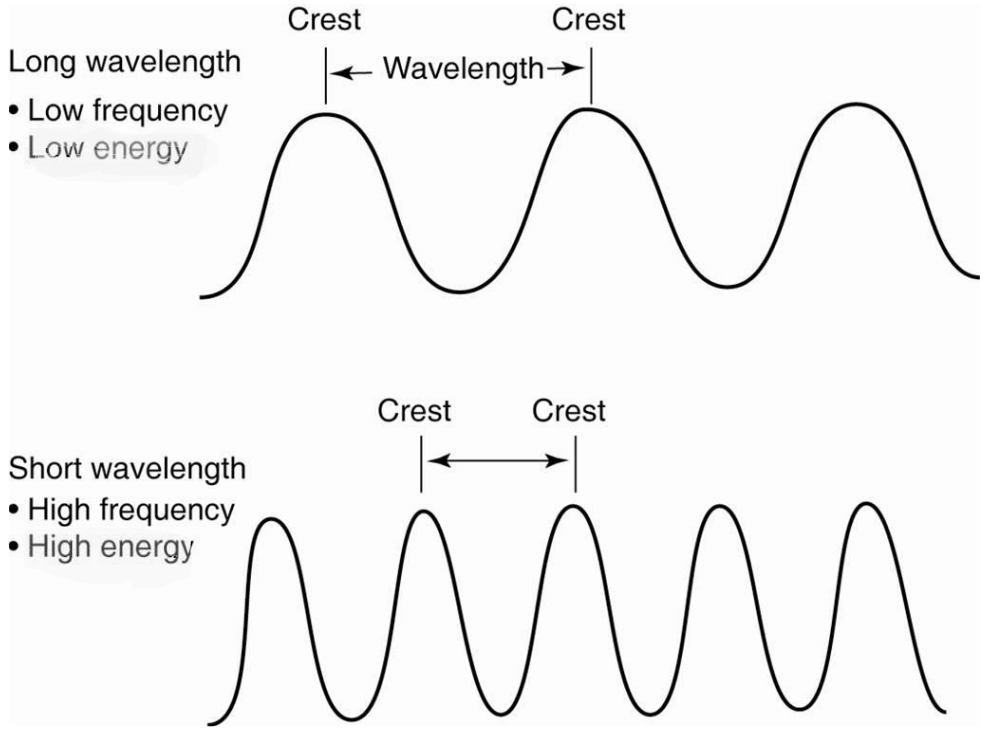
Electromagnetic Radiation

Properties:

- They differ in their power of penetration, which depends on the difference in their wavelength.



Electromagnetic Energy



Roentgen Rays

Roentgen Rays

X-rays are:

- Pure energy units.
- Belonging to the electromagnetic spectrum.
- Have a very short wavelength.
- Can produce images of body tissues.

Properties:

- Special properties
- General properties

Special Properties of Roentgen Rays

1

- They have a very short wavelength (λ).
  (0.1 A˚)

Shorter wave length ---------- Increase power of penetration.

Remember

Power of penetration depends on several factors:

1. Wavelength.
2. Atomic number of radiographed object.
3. Thickness of radiographed object.
4. Density of radiographed object.

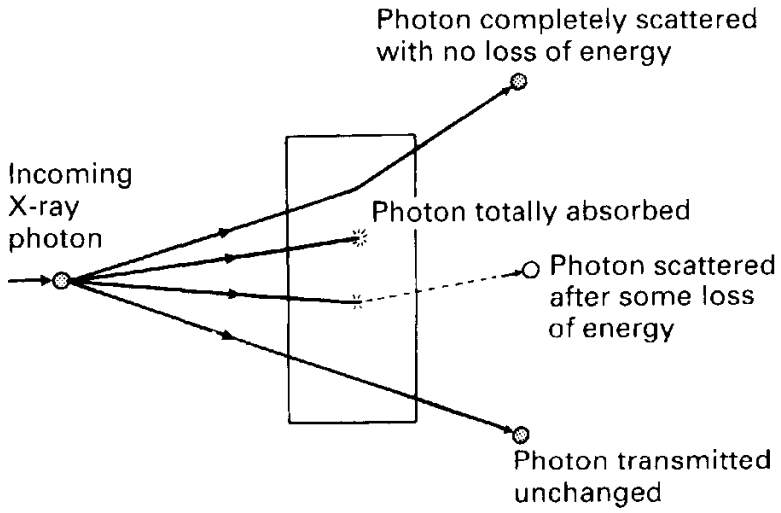
Remember

Factor	Character	Penetration	Absorption
Wavelength	Shorter	Increase	Decrease
Atomic number	Decrease	Increase	Decrease
Thickness	Decrease	Increase	Decrease
Density	Decrease	Increase	Decrease

Special Properties of Roentgen Rays

2

- They have a selective power of penetration and absorption.


Photon completely scattered with no loss of energy
Incoming X-ray photon
Photon totally absorbed
Photon scattered after some loss of energy
Photon transmitted unchanged

Special Properties of Roentgen Rays

3

- They affect photographic film emulsion.

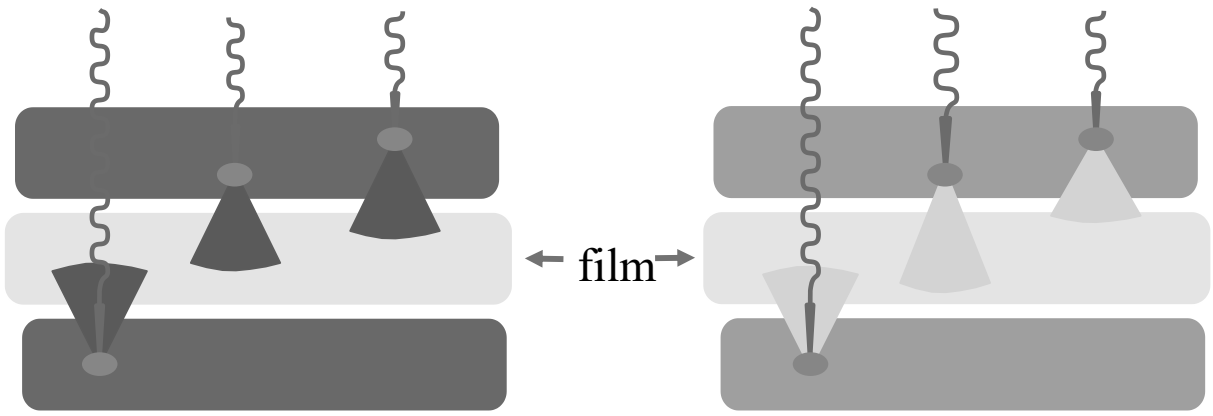
Film *X-Rays* latent image *processing* visible image

Special Properties of Roentgen Rays

4

- It can cause certain substance to fluoresce (emit radiation of longer wavelength).

Light Emission



= phosphor crystal

Special Properties of Roentgen Rays

5

- They cause ionization of atoms.

6

- They have biological damaging effect.

General Properties of Roentgen Rays

- They travel in straight lines, in a wave motion with the same speed of light.
- They are invisible, can't be smelled, heard or felt.

General Properties of Roentgen Rays

- They have no charge and no mass.
- They can’t be focused by a lens.
- Can’t be reflected by a mirror.
- Can’t be refracted in fluids.
- Can’t be deviated by a magnet.
- **Can only be deflected.**